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POLLUTION CONTROL AND THE RESTRICTION OF TRADE IN THE PRESENCE OF LOBBYING FOR THE ENVIRONMENT*

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Abstract

This paper examines how lobbying activity for protection of the environment affects the pollution and trade tax rates adopted by the government of a large importing country. We demonstrate that, under certain conditions on the structure of demand and supply, both the tax rates under lobbying are unambiguously higher than they would be in the absence of lobbying when the domestic government determines them simultaneously. In addition, we consider the effects of lobbying activity on the terms of trade and domestic prices.

Keywords: Pollution tax, trade tax, lobbying.
JEL classification: F18

I. *Introduction*

In the last few decades, the environment has been deteriorating worldwide. People have been made aware of environmental problems, such as global warming and the depletion of the ozone layer. Countries have reached an agreement that they should co-operate to find a solution to those environmental problems.[1] It is widely recognized that the first best solution is a combination of Pigouvian tax and free trade. If all countries adopted this combination with transfer payments, Pareto optimum could be achieved.[2] Hence, in terms of efficiency, trade policies should not be used for environmental purposes.

Some industrialized countries have insisted that trade and environmental policies should be coordinated by the World Trade Organization (WTO) since global environmental problems

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[1] The United Nations Framework Convention on Climate Change and the Montreal Protocol are examples.

[2] See Markusen (1975 b) and Bhagwati and Srinivasan (1996). Markusen (1975 b), Barrett (1994), Kennedy (1994), and Ulph (1996) compared 'the Prisoners' Dilemma' outcome with the Pareto optimum.

have become the main issue, rather than local environmental degradation.[3] In practice, the trade measures were put into effect to protect the environment outside the jurisdiction of the importing country.[4]

Lobbying activity is considered to be an important factor in the determination of environmental and trade policies. A number of environmental interest groups have been organized and, accordingly, the pressure for the environment and against increasingly free trade has grown.[5] Lobbying activity may influence government policy to become more conservationist and more trade-restrictive.

The purpose of this paper is to examine how lobbying for protection of the environment affects the pollution and trade tax rates adopted by the government of a large importing country. We show that, the effects of lobbying on the tax rates are ambiguous when the government can alter only one policy measure. The reason is that an increase (resp. a decrease) in the trade tax (resp. the pollution tax) rate decreases foreign production, which leads to a decrease in transboundary pollution, whereas domestic pollution increases. Which effect is greater depends on the structure of demand and supply and on the seriousness of transboundary pollution relative to domestic pollution. On the other hand, under certain demand and supply structures, the government of the importing country necessarily raises both tax rates when it is able to determine them simultaneously. The intuition is that the domestic government can set both taxes for different purposes. The pollution tax can be used to cope with domestic pollution and to make the sum of the consumers' surplus and the tax revenue favorable to the environmental lobby group, whereas the trade tax can be used to deal with foreign pollution and to make the terms of trade favorable to the domestic economy. Under certain demand and supply structures, those effects make both taxes higher. Moreover, we also consider the effects on the terms of trade and domestic consumer and producer prices.

Hillman and Urspring (1992) examined how environmental interest groups affect the trade policy that protects domestic industries from import competition under international oligopoly. Fredriksson (1997, 1999) was concerned with how lobbying activities by both environmentalists and producers affect the pollution tax rate and the amount of pollution emission in a small open economy model. However, they dealt with only one policy measure. In contrast to those analyses, we consider both the pollution and trade taxes simultaneously. Moreover, in contrast to Fredriksson (1997, 1999) we focus on a large importing country. Rauscher (1997) took into consideration several kinds of policies and examined the effect of lobbying activities both by the owners of the industry specific factor and the environmentalists in a small open economy. Although he also referred to the two-large-country case, he examined the case only with pollution taxes.

Schleich and Orden (2000) examined the effect of lobbying activity by producers on both

[3] The EU has insisted that 'trade and environment' should be negotiated. At the Doha Ministerial Conference, WTO members agreed to negotiations without prejudging their outcome on the elimination of tariff and non-tariff barriers to environmental goods and services in the next Work Programme. However, trade policies for environmental purposes will not be negotiated. See WTO (2001 a).

[4] See WTO home page (http://www.wto.org./) on the tuna-dolphin case and see WTO (1998) on the Shrimp-Sea turtle case. Ludema and Wooton (1994, 1997), and Furusawa, Higashida, and Ishikawa (2002) provided theoretical analyses of this type of trade measure.

[5] The failure of the Seattle Ministerial Meeting is a notable example. See Sampson (2000) on the environment and the World Trade Organization (WTO) after the Seattle Ministerial Meeting.

the pollution and trade taxes. In contrast to Schleich and Orden (2000), we deal with lobbying activity by environmentalists. Conconi (2000) examined the effect of environmental lobbying on both pollution and trade taxes in a symmetrical large country model. This study focused on a comparison of the equilibrium pollution tax rate in the presence of environmental lobbying and the Pigouvian rate. Since this study assumed symmetry between countries, no trade takes place in equilibrium. We do not assume symmetry, and can consider the effect that lobbying has on the restriction of trade.

There are three key features of this paper. First, we take into consideration transboundary pollution. Global environmental problems and transboundary pollution have become more serious and are difficult to resolve. Hence, we examine this type of pollution.[6]

Second, we employ the common agency model introduced by Grossman and Helpman (1994). In this model, an environmental interest group confronts the government with a contribution schedule. The incumbent government chooses both the pollution and trade tax rates to maximize a weighted sum of social welfare and total political contributions.

Third, we do not exclude the possibility that the environmental lobby group takes into consideration not only environmental degradation but also income redistribution. Aidt (1997) examined the effects of lobbying activity by environmentalists on production and raw material taxes in a small open economy and compared the case in which the environmental lobby group cares about income redistribution with the case in which it does not.

The paper is organized as follows. Section 2 describes the model. Section 3 examines the equilibrium tax rates. Two cases are considered. In the first, the government can use only one policy measure, the pollution tax or the trade tax. In the second case, the government can determine both the pollution and trade tax rates simultaneously. Section 4 deals with the effects of lobbying on the terms of trade and on domestic consumer and producer prices. Section 5 provides concluding remarks.

II. *The Model*

There are two large countries: one is the home country and the other is the foreign country. An asterisk (*) is used to denote foreign country variables. Assuming that foreign policies are given, we focus on the home country.

Following Fredriksson (1997), we assume that citizens are heterogeneous. The population of the home country is N, which is normalized to one. There are two types of citizens, workers and environmentalists. Both types have l units of labor. Environmentalists are concerned with environmental degradation, whereas workers are not. The fraction of environmentalists is α.

There are two sectors in both countries: one sector produces good z, which is the numeraire, and the other sector produces good x. There is no pollution associated with the production of z. The production of x emits pollution, which crosses the countries' border.

Utility for each environmentalist (i) is given by:

$$U_i^E = d_{z,\,i} + u[d_{x,\,i}] - \theta(X + \gamma X^*), \qquad u' > 0, \quad u'' < 0, \tag{1}$$

[6] In the case of a small open economy, transboundary pollution cannot be examined since such an economy cannot influence foreign production and, accordingly, foreign pollution.

where $d_x(d_z)$ and $X(X^*)$ denote the amount of $x(z)$ consumed by each individual and the amount of domestic (foreign) production, respectively. θ and γ denote disutility per unit of domestic production and the seriousness of disutility from a unit of foreign production relative to that from a unit of domestic production, respectively. If $\gamma<1$ (resp. $\gamma>1$), domestic environmentalists suffer more from a unit of domestic (resp. foreign) production than from a unit of foreign (resp. domestic) production. Square brackets represent functions throughout the paper. Similarly, utility for each worker (j) is given by:

$$U_j^W=d_{z,\,j}+u[d_{x,\,j}]. \tag{2}$$

Only labor is used to produce good z. The production technology exhibits constant returns to scale and an input-output coefficient equal to one. The units of good z are chosen so that its price equals unity in both countries. It is assumed that the aggregate supply of the input is sufficiently large to produce a positive amount of z. A competitive equilibrium then implies a wage rate equal to one.

Good x is produced using labor and a sector specific input, the supply of which is inelastic. A proportion, β, of citizens own specific factors. A proportion, λ, of these specific factor owners are environmentalists. All specific factor owners own the same amount of the factor. The production technology exhibits constant returns to scale. With the wage rate fixed to one, the specific factor reward is given by:

$$\pi=\Pi[p_x], \qquad \Pi'>0, \quad \Pi''>0, \tag{3}$$

where p_x denotes the producer's price. By Hotelling's lemma, the supply function is given by:

$$X[p_x]=\Pi'[p_x]. \tag{4}$$

We employ a common agency model of lobbying introduced by Grossman and Helpman (1994). Environmentalists in the domestic country organize themselves into a lobby group. They influence the government's policies by making campaign contribution schedules, $C[t, \tau]$, where t and τ denote the pollution tax rate and the trade tax rate, respectively. Following Fredriksson (1997), we assume that workers and foreign citizens do not organize a lobby group.[7]

Each environmentalist solves the following utility maximization problem:

$$max_{d_{z,\,i},\,d_{x,\,i}}U_i^E=d_{z,\,i}+u[d_{x,\,i}]-\theta(X+\gamma X^*) \tag{5}$$

$$s.t. \quad l+TR+I\frac{\pi}{\beta}=d_{z,\,i}+p_d d_{x,\,i}+C_i,$$

where p_d and TR denote, respectively, the consumer's price and the total tax revenue which is redistributed uniformly to all citizens. C_i represents the contribution borne by environmentalist i. Moreover, $I=1$ if a citizen (environmentalist or worker) owns the sector specific factor whereas $I=0$ if a citizen does not own the sector specific factor. Similarly, the utility maximization problem for each worker is:

$$max_{d_z,\,d_x}U_j^W=d_{z,\,j}+u[d_{x,\,j}] \tag{6}$$

[7] To focus on the effect of environmental lobbying activity, we do not consider industrialist or worker lobby groups.

$$s.t. \quad l + TR + I\frac{\pi}{\beta} = d_{z,j} + p_d d_{x,j}.$$

It is assumed that l is large enough to consume good z even if a citizen does not own the sector specific factor. From these maximization problems, we obtain the inverse demand function for good x:[8]

$$p_d = u'[D], \tag{7}$$

where D denotes the total demand. We examine two kinds of taxes, the pollution tax (t) and the trade tax (τ).[9] It is assumed that the home country imports good x. Then, the positive sign in relation to τ means that the domestic government has imposed a tariff.[10] Total tax revenue, which is distributed uniformly to all individuals, is written as:[11]

$$TR = \tau(D - X) + tX. \tag{8}$$

In contrast to Fredriksson (1997), since we assume that the country is large, the effect of the change in tax rates on the international price must be taken into consideration. From the law of one price, the following equation holds:

$$p_d = p_x + t = p + \tau, \tag{9}$$

where p denotes the international price. Moreover, since total world supply must equal total world consumption, the following equation holds:

$$M[p_d, p_x] + M^*[p_d^*, p_x^*] = 0, \tag{10}$$

where $M[p_d, p_x] = D[p_d] - X[p_x]$ and $M^*[p_d^*, p_x^*] = D^*[p_d^*] - X^*[p_x^*]$. From Equation (9), Equation (10) is rewritten as:

$$D[p + \tau] - X[p + \tau - t] + D^*[p + \tau^*] - X^*[p + \tau^* - t^*] = 0. \tag{11}$$

By the implicit function theorem and the assumption that foreign tax rates are fixed, the international price, p, can be written as a function of domestic tax rates, t and τ. Therefore, we obtain:

$$\frac{\partial p[t, \tau]}{\partial t} = -\frac{X'}{D' - X' + D^{*\prime} - X^{*\prime}}, \tag{12}$$

[8] In this model, environmentalists do not take environmental damage into consideration when determining the amount of consumption, although an increase in consumption causes environmental damage by increasing production. We implicitly assume that each individual's share of consumption is very small. However, this assumption is not crucial for our results. Even if environmentalists are assumed to consider the effect of their own consumption and consume less than workers, we obtain the same results.

[9] We do not take into account technology change. Consequently, the pollution tax has the same effect as the production tax.

[10] Any country participating in the WTO cannot use trade policy to affect the pollution that is emitted outside its jurisdiction. However, some multilateral environmental agreements (MEAs) have trade provisions, although clarification of the WTO-MEA interface is currently in dispute at the WTO (See WTO (1999, 2000, 2001 b)). Consequently, as noted in Markusen (1975), it is important to consider the incentives for a large country to influence foreign pollution in the presence of transboundary pollution.

[11] When the government can use only the trade tax, $TR < 0$ may hold. In this case, it is collected uniformly from all individuals.

$$\frac{\partial p[t, \tau]}{\partial \tau} = -\frac{D' - X'}{D' - X' + D^{*\prime} - X^{*\prime}}, \tag{13}$$

where:

$$D' = \frac{dD[p_d]}{dp_d}, \quad X' = \frac{dX[p_x]}{dp_x}, \quad D^{*\prime} = \frac{dD^*[p_d^*]}{dp_d^*}, \quad X^{*\prime} = \frac{dX^*[p_x^*]}{dp_x^*}.$$

From the assumption on the shape of u and Π, we obtain $D' < 0$ and $X' > 0$. With similar assumptions on the foreign demand and supply functions, we obtain $D^{*\prime} < 0$ and $X^{*\prime} > 0$.

Social welfare consists of the sum of labor income, the rewards to the specific factors, total tax revenue, and the consumers' surplus, minus the disutility from degradation of the environment:

$$W[t, \tau] = L + \pi + TR + \{u[D[p_d]] - p_d D[p_d]\} - \alpha\theta(X + \gamma X^*), \tag{14}$$

where L denotes the sum of labor income. The objective of incumbent politicians is to get re-elected. The probability of re-election depends positively on social welfare. Contributions can also be used to increase the probability of re-election since they can be used for election campaigns. Thus, the domestic government maximizes a weighted sum of social welfare and contributions from environmentalists:

$$\begin{aligned} GW[t, \tau; K] &= kC[t, \tau] + W[t, \tau] - C[t, \tau] \\ &= (k-1)C[t, \tau] + W[t, \tau] \\ &= KC[t, \tau] + W[t, \tau], \end{aligned} \tag{15}$$

where $K(=k-1>0)$ is the exogenously given weight that the government places on campaign contributions relative to social welfare.

The structure of the two-stage game is as follows. In the first stage, the environmental lobby group offers a contingent campaign contribution schedule to maximize the welfare of the group given by:

$$W^E[t, \tau] = \lambda\pi + \alpha\{L + TR + (u[D[p_d]] - p_d D[p_d]) - \theta(X + \gamma X^*)\}. \tag{16}$$

In the second stage, the domestic government sets the tax rates, and receives the contribution associated with those rates. It is assumed that the environmental lobby group never breaks its promise. It is also assumed that $\lambda \leq \alpha$ since our purpose is to extract the effect of lobbying activity not by the specific factor owners but by environmentalists.

The case of $\lambda = \alpha$ should be noted. It implies that the ratio of environmentalists to all citizens equals the ratio of the specific factors owned by environmentalists to all specific factors. In such a case, in comparison to social welfare, the domestic government gives weight only to the disutility from pollution emission. Therefore, with regard to the direction of tax rate changes, the results are the same as those when the environmental lobby group cares only about the disutility from pollution emission.

III. *Political Equilibria*

1. Equilibrium Characteristics

In this section, we describe political equilibria. We consider two cases: first, the government can set only one policy measure; and second, the government can set both the pollution and trade taxes simultaneously. We begin with the characterization of equilibria.

Following Proposition 1 in Grossman and Helpman (1994), if the domestic government can set both the tax rates simultaneously, an equilibrium can be characterized as follows:

Proposition 1. (C^0, t^0, τ^0) *is a Subgame Perfect Equilibrium iff*

(i) C^0 *is feasible for the environmental lobby group;*

(ii) (t^0, τ^0) *maximizes* $KC^0[t, \tau]+W[t, \tau]$ *on* T *where* T *denotes the government's two-dimensional choice set;*

(iii) (t^0, τ^0) *maximizes* $W^E[t, \tau]-C^0[t, \tau]+KC^0[t, \tau]+W[t, \tau]$;

(iv) $(\bar{t}, \bar{\tau})$ *maximizes* $KC^0[t, \tau]+W[t, \tau]$ *on* T *such that* $C^0[\bar{t}, \bar{\tau}]=0$, *where* $(\bar{t}, \bar{\tau})$ *denote the equilibrium tax rates without any lobbying activities*.

Condition (i) requires that the contribution schedule offered by the environmental lobby group is feasible. Condition (ii) implies that the government maximizes its own welfare (GW) given the contribution schedule offered. Condition (iii) implies that the joint welfare of the environmental lobby group and the government should be maximized in equilibrium. If this is not true, environmentalists can bias the equilibrium tax rates in favor of themselves by altering their contribution schedule. Condition (iv) implies that the environmental lobby group increases its welfare level by lowering its contribution schedule until the government is indifferent between (t^0, τ^0) and $(\bar{t}, \bar{\tau})$. In terms of the environmental lobby group's welfare, the former tax rates are preferable to the latter.[12]

Condition (iii) in Proposition 1 implies that:

$$\frac{\partial W^E[t^0, \tau^0]}{\partial \sigma} - \frac{\partial C^0[t^0, \tau^0]}{\partial \sigma} + K\frac{\partial C^0[t^0, \tau^0]}{\partial \sigma} + \frac{\partial W[t^0, \tau^0]}{\partial \sigma} = 0, \quad \text{for } \sigma = t \text{ or } \tau. \tag{17}$$

In addition, we obtain the following first order condition from Condition (ii) in Proposition 1:

$$K\frac{\partial C^0[t^0, \tau^0]}{\partial \sigma} + \frac{\partial W[t^0, \tau^0]}{\partial \sigma} = 0. \tag{18}$$

Thus, from Equations (17) and (18), we obtain the equilibrium characterization:

$$K\frac{\partial W^E[t^0, \tau^0]}{\partial \sigma} + \frac{\partial W[t^0, \tau^0]}{\partial \sigma} = 0. \tag{19}$$

If the domestic government can use only one policy measure, characterization of the equilibrium is similar. Therefore, Equation (19) can be rewritten as:

[12] For the intuition behind the case in which more than one lobby group exists, see Fredriksson (1997).

$$K\frac{\partial W^E[t^0;\hat{\tau}]}{\partial t}+\frac{\partial W[t^0;\hat{\tau}]}{\partial t}=0 \tag{20}$$

for the case of the pollution tax, and:

$$K\frac{\partial W^E[\gamma^0;\hat{t}]}{\partial \tau}+\frac{\partial W[\gamma^0;\hat{t}]}{\partial \tau}=0 \tag{21}$$

for the case of the trade tax, where $\hat{t}$ and $\hat{\tau}$ denote the exogenously given tax rates.

2. Equilibrium Situations with Single Policy Measure

We now examine the equilibrium situation in which the domestic government can alter only one policy measure in response to lobbying activity. First, we examine the case in which the domestic government can use only the pollution tax. The domestic government chooses the pollution tax rate to maximize its own welfare given the trade tax rate. From Equation (20), the first order condition is:

$$\begin{aligned}\frac{\partial GW[t;\hat{\tau},K]}{\partial t}&=K\frac{\partial W^E[t;\hat{\tau}]}{\partial t}+\frac{\partial W[t;\hat{\tau}]}{\partial t}\\&=(K\lambda+1)X\left(\frac{\partial p}{\partial t}-1\right)\\&\quad+(K\alpha+1)\left\{-D\frac{\partial p}{\partial t}+X+tX'\left(\frac{\partial p}{\partial t}-1\right)+\hat{\tau}\left(D'\frac{\partial p}{\partial t}-X'\left(\frac{\partial p}{\partial t}-1\right)\right)\right\}\\&\quad-\alpha(K+1)\theta\left\{X'\left(\frac{\partial p}{\partial t}-1\right)+\gamma X^{*\prime}\frac{\partial p}{\partial t}\right\}\\&=0.\end{aligned} \tag{22}$$

We assume that the second order condition for stability holds:

$$\frac{\partial^2 GW}{\partial t^2}<0. \tag{23}$$

Substituting Equation (12) into Equation (22), we obtain the equilibrium pollution tax rate:

$$\begin{aligned}t=&\frac{M}{D'+D^{*\prime}-X^{*\prime}}+\frac{K(\alpha-\lambda)X}{(K\alpha+1)X'}+\frac{(D^{*\prime}-X^{*\prime})\hat{\tau}}{D'+D^{*\prime}-X^{*\prime}}\\&+\frac{\alpha(K+1)\theta(D'+D^{*\prime}-(1-\gamma)X^{*\prime})}{(K\alpha+1)(D'+D^{*\prime}-X^{*\prime})}.\end{aligned} \tag{24}$$

The first term in the equilibrium tax rate is due to the terms of trade effect. The domestic government has an incentive to lower the tax rate, which leads to a lower international price. The second and third terms are due to a change in the sum of the consumers' surplus and the total tax revenue. The last term represents the tax on pollution emission. Taking into consideration both domestic and transboundary pollutions, the domestic government sets the pollution tax rate.

With regard to the effect of lobbying activity by environmentalists on the pollution tax rate, we obtain the following proposition.

Proposition 2. *Suppose that the domestic government can use only the pollution tax. If the disutility from a unit of foreign production is smaller than that from a unit of domestic production* ($\gamma<1$), *the pollution tax rate under lobbying is unambiguously higher than it would be in the absence of lobbying. However, if* $\gamma>1$, *the result may be reversed*.

See Appendix A for proof.

The intuition is as follows. If $\gamma<1$, an increase in the pollution tax rate unambiguously decreases the aggregate disutility from the pollution emission that is experienced by environmentalists. Moreover, a part of environmentalists, who do not own the specific factor, do not care about the reward to the specific factors. Therefore, if $\gamma<1$, the domestic government can improve its own welfare by raising the pollution tax rate.

Second, we examine the case in which the domestic government can use only the trade tax. The domestic government chooses the trade tax rate to maximize its own welfare given the pollution tax rate. From Equation (21), the first order condition is:

$$\begin{aligned}\frac{\partial GW[\tau;\hat{t},K]}{\partial\tau} &= K\frac{\partial W^E[\tau;\hat{t}]}{\partial\tau}+\frac{\partial W[\tau;\hat{t}]}{\partial\tau}\\ &=(K\lambda+1)X\left(\frac{\partial p}{\partial\tau}+1\right)\\ &\quad+(K\alpha+1)\left\{-D\left(\frac{\partial p}{\partial\tau}+1\right)+\hat{t}X'\left(\frac{\partial p}{\partial\tau}+1\right)+D-X+\tau(D'-X')\left(\frac{\partial p}{\partial\tau}+1\right)\right\}\\ &\quad-\alpha(K+1)\theta\left\{X'\left(\frac{\partial p}{\partial\tau}+1\right)+\gamma X^{*\prime}\frac{\partial p}{\partial\tau}\right\}\\ &=0. \end{aligned}\tag{25}$$

We assume that the second order condition for stability holds:

$$\frac{\partial^2 \mathrm{GW}}{\partial\tau^2}<0.\tag{26}$$

Substituting Equation (13) into Equation (25), we obtain the equilibrium trade tax rate:

$$\begin{aligned}\tau=&-\frac{M}{D^{*\prime}-X^{*\prime}}+\frac{K(\alpha-\lambda)X}{(K\alpha+1)(D'-X')}-\frac{\hat{t}X'}{D'-X'}\\ &\frac{\alpha(K+1)\theta\{X'(D^{*\prime}-X^{*\prime})-\gamma X^{*\prime}(D'-X')\}}{(K\alpha+1)(D'-X')(D^{*\prime}-X^{*\prime})}.\end{aligned}\tag{27}$$

The first term corresponds to a standard optimal tariff in the context of international economics, which is due to the terms of trade effect. The second and third terms are due to a change in the sum of the consumers' surplus and the total tax revenue. A change in the trade tax rate alters both domestic and foreign productions, which implies that both domestic and

foreign pollution emissions also change. This effect is represented by the last term.[13]

With regard to the effect of lobbying activity by environmentalists on the trade tax rate, we obtain the following proposition.

Proposition 3. *Suppose that the domestic government can use only the trade tax. If* $\gamma=0$ *the trade tax rate under lobbying is unambiguously lower than it would be in the absence of lobbying. Otherwise, the effect of lobbying activity by environmentalists on the direction of a change in the trade tax rate is ambiguous.*

See Appendix B for proof.

The intuition is as follows. $\gamma=0$ implies that there is no transboundary pollution. A decrease in the trade tax rate reduces domestic production, which leads to a decrease in the aggregate disutility from the pollution emission that is experienced by environmentalists. Moreover, similarly to the case of the pollution tax only, a part of environmentalists do not care about the reward to the specific factors. Therefore, if $\gamma=0$, the domestic government can improve its own welfare by lowering the trade tax rate.

3. The Equilibrium Situation with Both Pollution and Trade Taxes

In this subsection, we examine the equilibrium situation in which the government can use both the pollution and trade taxes simultaneously. We describe the equilibrium rates, and then compare the direction of the changes in the tax rates with the result obtained in the previous subsection.

The first order conditions are given by $\partial GW[t, \tau; K]/\partial t=0$ and $\partial GW[t, \tau; K]/\partial \tau=0$, which are the same as Equations (22) and (25). We assume that the following stability conditions hold:

$$\frac{\partial^2 GW}{\partial t^2}<0, \quad \frac{\partial^2 GW}{\partial \tau^2}<0, \quad \begin{vmatrix} \frac{\partial^2 GW}{\partial t^2} & \frac{\partial^2 GW}{\partial \tau \partial t} \\ \frac{\partial^2 GW}{\partial t \partial \tau} & \frac{\partial^2 GW}{\partial \tau^2} \end{vmatrix} = |G|>0. \tag{28}$$

Substituting Equations (12) and (13) into Equations (22) and (25), the equilibrium rates of pollution and trade taxes are written as follows:

$$t=\frac{K(\alpha-\lambda)X}{(K\alpha+1)X'}+\frac{\alpha(K+1)\theta}{K\alpha+1}, \tag{29}$$

$$\tau=-\frac{M}{D^{*\prime}-X^{*\prime}}-\frac{\alpha(K+1)\theta X^{*\prime}}{(K\alpha+1)(D^{*\prime}-X^{*\prime})}. \tag{30}$$

With regard to the effect of lobbying activity by environmentalists on the tax rates, we obtain the following proposition.

Proposition 4. *Suppose that the following two conditions hold simultaneously:*

$$X''\leq 0, \quad \textit{and} \tag{31}$$

[13] Markusen (1975 a) obtained this result in the absence of lobbying activity using a general equilibrium approach.

$$\frac{(K\alpha+1)(D-X)(X^{*\prime\prime}-D^{*\prime\prime})}{D^{*\prime}-X^{*\prime}}+\frac{\alpha(K+1)\theta\gamma(X^{*\prime\prime}D^{*\prime}-D^{*\prime\prime}X^{*\prime})}{D^{*\prime}-X^{*\prime}}\geq 0. \tag{32}$$

Then, both tax rates under lobbying are unambiguously higher than they would be in the absence of lobbying.

See Appendix C for proof and for the implications of the two conditions.

The effects on the tax rates in the case in which both taxes can be set simultaneously contrasts with those in the case in which the government can use only one policy measure. Proposition 4 implies that a large importing country necessarily increases the distortion from trade policy as long as the two conditions are satisfied.

The intuition is as follows. It is clear from Equation (29) that the pollution tax has two roles. One is to deal with domestic pollution, which must be higher with lobbying activity by environmentalists for a given τ. The other is to make the sum of the consumers' surplus and the total tax revenue favorable to the environmental lobby group, which may not be enhanced for a given τ. The latter role is specific to the case in which there is lobbying activity. It is also clear from Equation (30) that the trade tax has two roles. One is to make the terms of trade favorable to the domestic economy. The other is to deal with transboundary pollution. With lobbying activity by environmentalists, both effects do not necessarily make the trade tax rate higher for a given t. However, Proposition 4 implies that, in equilibrium, both tax rates eventually increase in the presence of lobbying activity by environmentalists as long as the two conditions are satisfied. The point is that the domestic government can use both taxes for different purposes.

Three points should be noted. First, the result does not depend on the share of the specific factors that are owned by environmentalists (λ). In the case in which the domestic government can use only one policy measure, it plays an important role in determining the effect of lobbying activity by environmentalists. However, it does not matter when the domestic government can set both taxes simultaneously.

Second, as long as the two conditions are satisfied, the result also does not depend on the seriousness of pollution emission from a unit of foreign production relative to that from a unit of domestic production (γ). For example, if the demand and supply functions are linear, irrespective of the value of γ, the two conditions are satisfied.

Third, it is possible that lobbying activity by environmentalists induces the domestic government to lower those tax rates if the two conditions in Proposition 4 are not satisfied. In such a case, the result obtained in Proposition 4 may be reversed.

IV. *Terms of Trade and Domestic Prices*

In the previous section, we showed that, under certain conditions, environmental lobbying activity provides the domestic government with an incentive to increase both the pollution and trade tax rates, when the government can set them simultaneously. However, we did not refer to the terms of trade (the international price) and the domestic consumer and producer prices. In this section, we consider the effect of lobbying activity by environmentalists on those prices.[14]

[14] We do not refer to the case with one policy measure explicitly since the results are obvious.

In particular, for simplicity, we focus on the case where demand and supply functions are linear ($D''=X''=D^{*''}=X^{*''}=0$), which satisfies the conditions in Proposition 4.[15]

First, we examine the terms of trade (the international price), p. From Equations (11), (44), and (47), the effect of lobbying activity by environmentalists is represented as:

$$\begin{aligned}\frac{dp}{dK} &= \frac{\partial p}{\partial t}\frac{dt}{dK} + \frac{\partial p}{\partial \tau}\frac{d\tau}{dK} \\ &= -\frac{D'}{|G|}\frac{\partial p}{\partial t}\left\{(\alpha-\lambda)X\left(\frac{\partial p}{\partial \tau}+1\right)+\alpha(1-\alpha)\theta\left(X'\left(\frac{\partial p}{\partial \tau}+1\right)+\gamma X^{*\prime}\frac{\partial p}{\partial \tau}\right)\right. \\ &\quad \left. + \frac{K\alpha(\alpha-\lambda)(1-\alpha)\theta\gamma X^{*\prime}}{K\alpha+1}\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)\right\}. \qquad (33)\end{aligned}$$

Since $\partial p/\partial t>0$ and $\partial p/\partial \tau<0$ hold, it is clear that the effect of an increase in the pollution tax rate and the effect of an increase in the trade tax rate work in opposite directions. Thus, the effect of lobbying activity by environmentalists on the international price is generally ambiguous. This implies that the increase in the trade tax rate does not necessarily reduce the volume of trade.

However, one point should be noted. The first two terms in the braces of Equation (33) are the same as in Equation (37). The third term in the braces is negative, which does not appear when the domestic government can use only the trade tax rate. In comparison to the case with the trade tax only, the domestic government has an additional incentive to restrict trade. The intuition is as follows. From Equation (30), the role of the trade tax in dealing with transboundary pollution is enhanced by the lobbying activity of environmentalists. However, if the domestic government cannot alter the pollution tax rate, the domestic government must take into consideration domestic pollution and the sum of the consumers' surplus and the total tax revenue when it sets the trade tax rate, which weakens the domestic government's incentive to raise the trade tax. For example, an increase in the trade tax rate necessarily increases domestic pollution. On the other hand, if the domestic government can alter the pollution tax rate, it can deal with domestic pollution and the sum of the consumers' surplus and the total tax revenue by changing the pollution tax rate. Therefore, the constraint on the trade tax rate does not exist.

Next, we examine the domestic consumer price, $p+\tau$. From Equations (11), (44), and (47), the effect of lobbying activity by environmentalists is represented as:

$$\frac{d(p+\tau)}{dK} = \frac{\partial p}{\partial t}\frac{dt}{dK} + \left(\frac{\partial p}{\partial \tau}+1\right)\frac{d\tau}{dK} > 0. \qquad (34)$$

Thus, we find that lobbying activity by environmentalists necessarily raises the domestic consumer price. This result contrasts with the case with one policy measure.

Finally, we examine the domestic producer's price, $p+t-\tau$. From Equations (11), (44), and (47), the effect of lobbying activity by environmentalists is represented as:

$$\frac{d(p+t-\tau)}{dK} = \left(\frac{\partial p}{\partial t}-1\right)\frac{dt}{dK} + \left(\frac{\partial p}{\partial \tau}+1\right)\frac{d\tau}{dK}$$

[15] Even if we consider the case in which demand and supply functions are not linear, the results do not change as long as the conditions in Proposition 4 are satisfied.

$$= -\frac{D'}{|G|}\left(\frac{\partial p}{\partial \tau}+1\right)\Bigg[((\alpha-\lambda)X+\alpha(1-\alpha)\theta X')\left\{\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)+\left(\frac{\partial p}{\partial t}-1\right)\right\}$$

$$+\alpha(1-\alpha)\theta\gamma X^{*\prime}\frac{\partial p}{\partial t}\Bigg]. \tag{35}$$

As with the case of the international price, it is clear that the effect of an increase in the pollution tax rate and the effect of an increase in the trade tax rate work in opposite directions. Thus, the effect of lobbying activity by environmentalists on the domestic producer price is generally ambiguous. This implies that lobbying activity by environmentalists does not necessarily disadvantages the domestic owners of the specific factor.

However, compared with Equation (36), an additional term exists in Equation (35), $\partial p/\partial t+\partial p/\partial \tau$, which is negative. This implies that, in comparison to the case with the pollution tax only, the domestic government has an additional incentive to restrict domestic production. The reason is that, if the domestic government cannot alter the trade tax rate, the domestic government must take into consideration the terms of trade effect and foreign pollution when it sets the pollution tax rate, which weakens the domestic government's incentive to raise the pollution tax. For example, an increase in the pollution tax rate necessarily increases the foreign pollution. On the other hand, if the domestic government can alter the trade tax rate, it can deal with foreign pollution and the terms of trade effect by changing the trade tax rate. Therefore, the constraint on the pollution tax rate does not exist.

V. *Concluding Remarks*

In this paper we have examined the effects of lobbying activity by environmentalists on the pollution and trade tax rates adopted by the government of a large importing country. We have employed the common agency model introduced by Grossman and Helpman (1994).

First, we have considered the case in which the government could use only one policy measure. We have demonstrated that the effects of lobbying activity by environmentalists on the tax rates are ambiguous. The direction of a change in each tax rate depends not only on the structure of demand and supply but also on the seriousness of pollution emission from a unit of foreign production relative to that from a unit of domestic production and on the share of the specific factors owned by environmentalists.

Second, we have examined the case in which the government could set both the pollution and trade tax rates simultaneously. In this case, under certain conditions on the structure of demand and supply, both tax rates are unambiguously higher when there is lobbying by environmentalists than they would be in the absence of lobbying.

Third, we have examined the effects on the terms of trade and domestic prices. We have demonstrated that the domestic consumer's price necessarily rises when the domestic government can use both the pollution and trade taxes. Moreover, lobbying activity by environmentalists might worsen the terms of trade of the foreign country. If the domestic government can use both taxes, it has an additional incentive to lower the international price in comparison to the case in which it can alter only the trade tax.

The case of a small open economy is worth mentioning. A small open economy cannot influence the international price and, accordingly, transboundary pollution. Therefore, the

domestic government cannot use taxes both to deal with transboundary pollution and to make the terms of trade favorable to the domestic economy. Therefore, the trade tax rate equals zero and is not influenced by lobbying activity, when the domestic government can set both the tax rates simultaneously. However, the trade tax rate may not equal zero when the domestic government can alter only the trade tax, since it can be used to deal with domestic pollution.

It should be noted that some issues are beyond the scope of this paper. First, we have not considered the response of the foreign government, or lobbying by foreign environmentalists, which we intend to do in the future. Second, we have not taken into account lobbying by producers. The case in which both lobby groups exist is also worth examining.

Nevertheless, the propositions obtained in this paper have important policy implications, since some existing multilateral environmental agreements (MEAs) contain trade provisions, and, without the hope of establishing an MEA on transboundary pollution between almost all countries, incentives and pressure for unilateral trade measures to be undertaken to protect the global environment will increase.

APPENDIX

A Proof of Proposition 2

From Equation (22), we obtain:

$$\frac{\partial^2 GW}{\partial K \partial t} = -\frac{1}{K\alpha+1} \cdot \left\{(\alpha-\lambda)X\left(\frac{\partial p}{\partial t}-1\right)+\alpha(1-\alpha)\theta\left(X'\left(\frac{\partial p}{\partial t}-1\right)+\gamma X^{*\prime}\frac{\partial p}{\partial t}\right)\right\}. \quad (36)$$

If $\gamma<1$, $X'(\partial p/\partial t-1)+\gamma X^{*\prime}\partial p/\partial t<0$ holds. Thus, $d^2GW/dKdt>0$ if $\gamma<1$. *Q.E.D.*

B Proof of Proposition 3

From Equation (25), we obtain:

$$\frac{\partial^2 GW}{\partial K \partial \tau} = -\frac{1}{K\alpha+1} \cdot \left\{(\alpha-\lambda)X\left(\frac{\partial p}{\partial \tau}+1\right)+\alpha(1-\alpha)\theta\left(X'\left(\frac{\partial p}{\partial \tau}+1\right)+\gamma X^{*\prime}\frac{\partial p}{\partial \tau}\right)\right\}. \quad (37)$$

If $\gamma=0$, $d^2GW/dKd\tau<0$ since $0<\partial p/\partial\tau+1<1$. *Q.E.D.*

C Proof of Proposition 4

Suppose that:

$$\Psi_1 = \frac{K(\alpha-\lambda)XX''}{X'},$$

$$\Psi_2 = \frac{(K\alpha+1)(D-X)(X^{*\prime\prime}-D^{*\prime\prime})}{D^{*\prime}-X^{*\prime}},$$

$$\Psi_3 = \frac{\alpha(K+1)\theta\gamma(X^{*\prime\prime}D^{*\prime}-D^{*\prime\prime}X^{*\prime})}{D^{*\prime}-X^{*\prime}}.$$

As noted in the paragraphs right after Proposition 4, the domestic government can benefit from the following four factors: to make the sum of the consumers' surplus and the total tax revenue favorable to the environmental lobby group; to deal with domestic pollution; to make the terms of trade favorable to the domestic economy; and to deal with transboundary pollution. It is clear from Equation (29) that Ψ_1 represents the effect of the second derivative of the domestic supply function on the first factor. Similarly, from Equation (30), Ψ_2 and Ψ_3 represent the effects of the second derivatives of the foreign demand and supply functions on the third and the forth factors, respectively. The second factor does not depend on the second derivatives of the demand and supply functions.

If the first condition in Proposition 4 ((31)) is satisfied, $\Psi_1 \leq 0$ holds. The second condition in Proposition 4 ((32)) is the same as $\Psi_2 + \Psi_3 \geq 0$.

From Equations (22) and (25), we obtain:

$$\frac{\partial^2 GW}{\partial t^2} = (K\lambda + 1)X'\left(\frac{\partial p}{\partial t} - 1\right)^2 - (K\alpha + 1)D'\left(\frac{\partial p}{\partial t}\right)^2 + 2(K\alpha + 1)X'\left(\frac{\partial p}{\partial t} - 1\right) + \Psi_1\left(\frac{\partial p}{\partial t} - 1\right)^2 - (\Psi_2 + \Psi_3)\left(\frac{\partial p}{\partial t}\right)^2, \tag{38}$$

$$\frac{\partial^2 GW}{\partial \tau^2} = (K\lambda + 1)X'\left(\frac{\partial p}{\partial \tau} + 1\right)^2 - (K\alpha + 1)D'\left(\frac{\partial p}{\partial \tau} + 1\right)^2 + 2(K\alpha + 1)(D' - X')\left(\frac{\partial p}{\partial \tau} + 1\right) + \Psi_1\left(\frac{\partial p}{\partial \tau} + 1\right)^2 - (\Psi_2 + \Psi_3)\left(\frac{\partial p}{\partial \tau}\right)^2, \tag{39}$$

$$\frac{\partial^2 GW}{\partial t \partial \tau} = (K\lambda + 1)X'\left(\frac{\partial p}{\partial t} - 1\right)\left(\frac{\partial p}{\partial \tau} + 1\right) - (K\alpha + 1)D'\frac{\partial p}{\partial t}\left(\frac{\partial p}{\partial \tau} + 1\right) 2(K\alpha + 1)X'\left(\frac{\partial p}{\partial \tau} + 1\right) + \Psi_1\left(\frac{\partial p}{\partial t} - 1\right)\left(\frac{\partial p}{\partial \tau} + 1\right) - \frac{\partial p}{\partial t}\frac{\partial p}{\partial \tau}(\Psi_2 + \Psi_3). \tag{40}$$

Thus, if $\Psi_1 \leq 0$ and $\Psi_2 + \Psi_3 \geq 0$ hold, the stabilitiy conditions, (28), hold. Moreover, the following inequality holds:

$$\frac{\partial^2 GW}{\partial t \partial \tau} > 0, \tag{41}$$

which implies that the domestic government has an incentive to raise one tax rate as the other tax rate increases. In other words, the two taxes are complements.

Since the domestic government can set both the pollution and trade tax rates simultaneously, changes in those rates according to a small increase in K can be written as follows:

$$\frac{dt}{dK}=\begin{vmatrix} -\frac{\partial^2 GW}{\partial K\partial t} & \frac{\partial^2 GW}{\partial t\partial \tau} \\ -\frac{\partial^2 GW}{\partial K\partial \tau} & \frac{\partial^2 GW}{\partial \tau^2} \end{vmatrix} \Bigg/ \begin{vmatrix} \frac{\partial^2 GW}{\partial t^2} & \frac{\partial^2 GW}{\partial t\partial \tau} \\ \frac{\partial^2 GW}{\partial t\partial \tau} & \frac{\partial^2 GW}{\partial \tau^2} \end{vmatrix}, \tag{42}$$

$$\frac{d\gamma}{dK}=\begin{vmatrix} \frac{\partial^2 GW}{\partial t^2} & -\frac{\partial^2 GW}{\partial K\partial t} \\ \frac{\partial^2 GW}{\partial t\partial \tau} & -\frac{\partial^2 GW}{\partial K\partial \tau} \end{vmatrix} \Bigg/ \begin{vmatrix} \frac{\partial^2 GW}{\partial t^2} & \frac{\partial^2 GW}{\partial t\partial \tau} \\ \frac{\partial^2 GW}{\partial t\partial \tau} & \frac{\partial^2 GW}{\partial \tau^2} \end{vmatrix}. \tag{43}$$

Substituting Equations (36), (37), (39), and (40) into Equation (42), we obtain:

$$\begin{aligned}\frac{dt}{dK}=\frac{1}{|G|}\cdot\Bigg[&((\alpha-\lambda)+\alpha(1-\alpha)\theta X')D'\left(\frac{\partial p}{\partial \tau}+1\right)\left(\frac{\partial p}{\partial \tau}-1\right)\\ &-\frac{K\alpha(\alpha-\lambda)(1-\alpha)\theta\gamma X'X^{*\prime}}{K\alpha+1}\left(\frac{\partial p}{\partial \tau}+1\right)\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)\\ &+\frac{\Psi_1\alpha(1-\alpha)\gamma X^{*\prime}}{(K\alpha+1)}\left(\frac{\partial p}{\partial \tau}+1\right)\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)\\ &+\frac{((\alpha-\lambda)X+\alpha(1-\alpha)\theta X')}{K\alpha+1}\frac{\partial p}{\partial \tau}\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)\cdot(\Psi_2+\Psi_3)\Bigg]\end{aligned} \tag{44}$$

From Equations (12) and (13):

$$\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}<0 \tag{45}$$

holds. Thus, if $X''\leq 0$ (*or* $\Psi_1\leq 0$) and $\Psi_2+\Psi_3\geq 0$ hold:

$$\frac{dt}{dK}>0. \tag{46}$$

On the other hand, substituting Equations (36), (37), (38), and (40) into Equation (43), we obtain:

$$\begin{aligned}\frac{d\tau}{dK}=-\frac{1}{|G|}\cdot\Bigg[&((\alpha-\lambda)X+(1-\alpha)\theta X')D'\left(\frac{\partial p}{\partial \tau}+1\right)\frac{\partial p}{\partial \mathrm{t}}\\ &+(1-\alpha)\theta\gamma X'X^{*\prime}\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)\left\{1-\frac{K(\alpha-\lambda)}{K\alpha+1}\cdot\left(\frac{\partial p}{\partial t}-1\right)\right\}\\ &-\frac{\Psi_1\alpha(1-\alpha)\gamma X^{*\prime}}{(K\alpha+1)}\left(\frac{\partial p}{\partial \mathrm{t}}-1\right)\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)\\ &-\frac{((\alpha-\lambda)X+\alpha(1-\alpha)\theta X')}{K\alpha+1}\frac{\partial p}{\partial \mathrm{t}}\left(\frac{\partial p}{\partial t}+\frac{\partial p}{\partial \tau}\right)(\Psi_2+\Psi_3)\Bigg].\end{aligned} \tag{47}$$

Thus, if if $X''\leq 0$ (*or* $\Psi_1\leq 0$) and $\Psi_2+\Psi_3\geq 0$ hold:

$$\frac{d\tau}{dK}>0. \tag{48}$$

Q.E.D.

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